Ideal Gas Law (pV = nRT)

In the example with the balloons at STP (Standard Temperature Pressure), the *n* is the number of moles [m(ass)/mw (molecular weight)] and is determined by using the ideal gas law.

Example:
How many moles (*n*) of He are in the 2.0L He balloon at STP?

Solve:
- What information is given and what is being asked?
- STP assumes temperature (T) = 298 K, and pressure (p) = 1.00 atm.
- Volume (V) = 2.00 L, and (R) is a constant 0.080206 L·atm/mol·K.

pV = nRT

n = pV/RT

n = (1.0 atm)(2.0L)/(0.080206 L·atm/mol·K)(298K)

n = 0.0817866 mol

n = 0.0818 mol He (3 sig figs) or 8.18 x 10^{-2} mol He

All four balloons have the same number of moles under the same constant conditions (temp., pressure, volume) under the Ideal gas law. They felt different due to the difference in molecular weight of each gas element.

He (4g/mol) < N_2 (28g/mol) < CO_2 (44g/mol) < SF_6 (146g/mol)

Particle Density

In a closed system, as pressure is increased, density also increases. So pressure is proportional to Particle Density at constant temperature and number of moles. Under these same conditions, Particle Density is inversely proportional to Volume.

Example Ideal Gas Question:
Calculate the molar mass of a vapor that has a density of 7.135g/L at 12ºC and 743 torr?

Solve:
- What information is given and what is being asked?

Calculate the **molar mass** of a **vapor** that has a **density of 7.135g/L** at **12ºC** and **743 torr**?

The given:
- the word **vapor** means gas, and suggests it is a gas law problem
- **density** = 7.135g/L   Remember: n (# of moles) = (mass/molar mass or molecular weight)
- **12ºC** = 298K   12 + 273.15 = 298K (in most cases, convert Celsius to Kelvins)
- **743 torr** = .977 atm   743/760 = 0.977 atm (in most cases, convert torr to atm). 760 torr=1atm.

The question asks for molar mass! Know that n = # moles.

$$n = (mass/molar\ mass)$$

$$molar\ mass = mass\ /\ n$$

Apply the equation:

$$pV = nRT$$

$$n = pV/RT$$

$$molar\ mass = DRT/p \qquad derived\ from\ D = (mass/V)/(n/V)$$

$$mw = \frac{(7.135g/L)(0.080206\ L \cdot atm/mol \cdot K)(285K)}{(743/760)atm}$$

$$mw\ of\ gas = 171\ g/mol$$